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FIELD GUIDE TO TUNDRA LICHENS OF
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From: State Director

Subject: Field Guide to Tundra Lichens of Alaska

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Lichens are important constituents of tundra plant communities which are too often ignored or overlooked by persons describing range or wildlife habitats. This is partly due to lack of good field guides or training in lichen identification.

The enclosed draft Field Guide to Tundra Lichens of Alaska is a first step toward meeting our needs for identifying lichens in the field. This draft contains keys to the identification of approximately 100 species of mostly fruticose (shrubby) lichens found on tundra ranges in Alaska. Keys to an additional 100 species of foliose (leafy) lichens will be added this winter.

By the summer of 1982 we hope to have a more-or-less complete field guide which can be issued to all your personnel who need such information. The final guide will contain text and some illustrations, but preparing the keys had priority over text for this first working draft. The present draft, however, should be field tested this summer so that we can see how well it meets your needs and where to clarify specific points.

This draft field guide contains references (in the keys) to pertinent illustrations found in other lichen books, and it should be used in conjunction with the illustrated references whenever possible. Since no illustrations are included at this time, one side of each sheet has been left blank to accommodate the user's notes and sketches.

We request that you ask your employees to use this identification guide in the field this summer and make notes and comments on the pages provided. Notations can be photocopied and submitted with other comments immediately after the field season. Please send your comments to Marianne See in Division of Resources (930) by October 9, 1981.

Fred Wolf

Enclosure

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**Field Guide
to
Tundra Lichens of Alaska**

Prepared by Marianne G. See, Botanist, BLM Alaska
State Office, for use in the BLM course,
"Field Identification of Tundra Range Lichens"

Presented May 28 and 29, 1981, Anchorage District
Office, and June 1 and 2, 1981, Fairbanks District
Office

**U. S. DEPARTMENT OF THE INTERIOR
Bureau of Land Management**



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INTRODUCTION

Lichens of many shapes and colors are a common sight in arctic and alpine tundra. In tundra regions lichens can be very important food for caribou and reindeer, especially in winter when green plants are not available. Many publications have been written on this subject and related work is in progress across northern North America, the USSR and Scandinavia. Thus, there is an ongoing need for naturalists, scientists, and range managers alike to identify the different types of northern lichens.

Unlike other plants, lichens are really the result of an algae and a fungus living together to form one "plant". What we see is mostly fungal tissue, while the tiny algae cells are located under the upper layers of the fungus where they photosynthesize food for themselves and for the fungus. This is a symbiotic relationship, which simply means that the two organisms live together. This symbiosis is to the general benefit of both organisms so it is mutualistic. However, the fungus places more physiological demands on the algae than the other way around, so there is an element of parasitism too. Because the fungi which live with algae apparently do not survive on their own, they are in a "lichenized" state.

The different fungi in lichens grow in distinct shapes and colors which are named as lichen species. The species name actually refers to the fungus which in turn associates with an algae. The algae has its own species name. We know very little about the genetics of lichenized fungi so we have to assume that the differences we see in shapes, colors, and chemistry do indicate real species differences.

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The most complete reference for identifying arctic tundra lichens is Thomson's recent book entitled Lichens of the Alaskan Arctic Slope (1979). This book includes identification keys for the tiny crustose lichens as well as larger foliose (leaf-like) and fruticose (stalk-like) lichens. These keys are quite technical because of their specialized terminology and lack of illustrations. They also use several characteristics which cannot easily be used in field identification such as chemical analyses. Therefore, the inexperienced lichen taxonomist should initially be using a more simplified reference. The only book which comes close to meeting this need has actually been written for Denmark, Norway, Finland, and Sweden (Dahl and Krog 1973). Many of those species are also found in Alaska, but some non-Alaskan species are included while some Alaskan species are omitted. We really do not have any simplified lichen guides for Alaska, nor for any region within Alaska. While a statewide book of lichen species was completed a few years ago (Krog 1968), no keys are included so the user must borrow technical keys from other sources.

THE LICHEN GUIDE

The present guide is designed to meet part of the need for simplified field keys for Alaskan lichens. The lichen species in these keys are characteristically found in alpine and arctic tundra. While many of these species may also be found in forested regions, the keys exclude lichens which are restricted to forest regions.

The keys first sort out individual genera, then separate keys are used to get to the species level. The major characteristics for sorting lichens include

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growth form, color, gross morphology, and habitat. Since lichen species in a particular genus may or may not look similar to each other, a given species will key out under the genus (or genera) which it most strongly resembles. This means that the keys are "artificial," compared to "natural" keys which group all species strictly by genus and family. Artificial keys are usually much easier for beginners to use because it is not necessary to have previous taxonomic experience with a lichen genus in order to key the species within it.

The unique chemicals produced by lichens are used in many keys to distinguish species. They may be used when the chemical reaction is either unique to one species in a group or genus, or when two species cannot be distinguished by morphology alone. In this guide the chemistry is not used to key the species but the important chemical reactions are included where each species or group of species will key out. This allows the user to have the chemical information, without requiring chemical tests for the keys.

LICHEN IDENTIFICATION

Growth Form

The first important criterion in lichen identification is to assess the growth form of the entire lichen (plant) or thallus. There are five growth forms which are recognized in this guide.

The crustose lichen growth form has simplest structure because it is always closely appressed to the substrate. There is an upper protective layer or

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cortex of fungal cells which is similar in function to the epidermis of a leaf. Below this layer is the medulla which is the main part of a lichen. It consists of thread-like fungal strands. In the upper part of the medulla there is an algal layer, where the algal cells are well-situated to receive light yet are protected by the upper cortex. In crustose lichens the lower part of the medulla is attached directly to the substrate. Since crustose lichens are very small, they are often called microlichens.

In foliose lichens the thallus is leaf-like and has a lower cortex below the medulla, which attaches it to the substrate. Root-like structures called rhizines often project down from the lower cortex to help anchor the lichen on trees, rocks and soil. Foliose lichens are more variable in shape than crustose lichens because they can grow taller yet still remain partially attached.

Fruticose lichens are round in cross section, and therefore do not have a lower cortex. There is usually an outer cortex surrounding the algal layer and medulla. In some genera the medulla may have a hollow core (e.g. Cladina), while in others there may be a dense central "cord" (e.g. Usnea).

Some fruticose lichens look a bit flattened or angular, but can be identified as fruticose by looking at the continuous internal layers in cross section. This test also applies to foliose lichens with edges which curl around to look fruticose as in Cetraria cucullata.

The fruticose growth form allows more variation in lichen size, shape, and branching than in either crustose or foliose forms. Fruticose lichens vary

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from simple horn-like thallii to intricately branched species as in reindeer lichens. Some species form goblet-like cups at the tips of long "stalks". The keys in this guide distinguish between the "cup and horn" fruticose species and the highly branched species.

There are two other common growth forms which are intermediate to foliose and fruticose forms. One is the squamulose growth form which consists of squamules or tiny scale-like lobes. Many cup and horn lichens initially start out as a squamulose thallus which then develops the secondary cups or horns. Some soil and rock lichens are squamulose and do not develop any kind of secondary stalk or branching.

The other important growth form is umbilicate, and refers to a central stalk (umbilicus) which supports a circular, foliose thallus. This growth form characterizes the lichen genus Umbilicaria which has many species that commonly grow on rocks. These species are often called rock tripes.

The lichen keys in this guide include foliose, umbilicate, squamulose, and fruticose growth forms which are commonly called macrolichens. Crustose growth forms or microlichens are excluded.

Few crustose lichens can be identified in the field because the primary taxonomic criteria are based upon microscopic or chemical features. For these lichens the reader should consult Thomson's (1979) crustose lichen keys for the North Slope.

USING THE LICHEN KEYS

Before starting to use the lichen keys, read the introductory text which explains many of the new terms, and features of this guide. Technical terms have been used only where they are also common in other lichen keys. In the keys they are usually preceded by a more general, nontechnical term, and are also defined in the glossary section of this and other lichen books.

The first step in identifying a lichen is to work through the Master Key. This key is designed to direct you to a more specific key which includes a group of similar-looking species.

All keys in this guide are arranged with pairs of alternative descriptions, or couplets, to choose from. For example, under number one in the Master Key there are two alternatives. The upper one is "lichen thallus fruticose..." and leads to couplet number two. The lower one is "lichen thallus foliose..." and leads to Key 8. There are never more than two alternatives in a couplet so the keys are strictly dichotomous.

In each key the couplets all have numbers, and beyond the first one in each key, there is another number in parentheses. This second number is the couplet which you just came from. With this second number you can keep your place as you move through the key, and also work backwards if you come to an impasse.

Once you have worked through the Master Key to another key, you can key to species. Where a genus has several species, you can key to the genus and then decide if you need species names or not. If you do not need species names for your purposes, you could stop at the genus, or at a group of species such as brown Cetraria species.

In the current draft there are no illustrations, so page numbers of illustrations from other keys are referenced where appropriate. The full reference to illustrations in Dahl and Krog is:

Dahl, Eilif and Hildur Krog. 1973. Macrolichens of Denmark, Finland, Norway, and Sweden. Scandinavian University Books, Oslo.
185 p.

The reference to Hale is to the second edition of his North American keys:

Hale, Mason E. 1979. How to Know the Lichens. Wm. C. Brown Co.,
Dubuque, Iowa. 246 p.

The first edition was published in 1969 and does not have the same paging nor does it have all the revisions and additional species of the newer version.

Another important difference between the first and second edition

of Hale's book is the improved quality of the plate of lichen colors just inside the front cover. The color of a lichen is very important in keys, and this color plate should be used for comparing a specimen to the reference colors. The newer edition has virtually true color while the original edition has a plate with too much blue in it. When placing a lichen on this plate to determine color, remember the color bias of the older edition if you are using that reference.

In addition to color, lichen size is also an important feature which is used in keys. The width of lobes and of whole lichens should be measured. Estimations are usually inaccurate, at least at first, because lichens seem bigger than they really are. Where the keys specify a size range, measure the specimen with a small metric ruler.

There are some species of lichens which vary so much in color or shape that the variations might key out in more than one place. The keys are designed with this in mind, so that any common variations will key with similar-looking species. Variability of color and shape is frequently related to conditions in specific microhabitats, especially the amount of exposure to wind (stunting) or direct light (sun-browning). Variations are common in several arctic species which look very different in exposed sites than in sheltered ones.

Some of the morphological features mentioned in the keys are very tiny and difficult to see without magnification. A 10X handlens or

magnifying glass will work well for seeing such minute features, and an inexpensive lens is adequate for the occasional user. Whenever the keys refer to using a handlens, the assumed magnification is 10 times or 10X. When it is possible to use a dissecting microscope, it is important to generally resist the temptation to use high magnification because it can be unnecessarily confusing.

In a few cases, two or more species look almost identical but are chemically different. There is a note about this in the couplet wherever it applies so you can decide if you want to have the species name, or the name of the group of these similar species. If you choose not to differentiate these "chemical species", then you should use one of three possible designations. For example, if you have a specimen of Cladina which is either C. arbuscula or C. mitis but do not need to know which, you would designate it as C. arbuscula/mitis, C. arbuscula aggr. (which means aggregate), or C. arbuscula s.l. / or C. mitis s.l. The s.l. stands for sensu lato which means "in the broad sense". Both "s.l." and "aggr." can be used where more than two species are involved. These designations allow you to indicate that other species were present, but that you did not use the necessary chemical criteria to distinguish them.

This sentence seems awkward due to "either", "or" usage. Suggest using two sentences instead.

Once you have decided that you have keyed your specimen to a particular species, check the index and text of Hale (1979), Dahl and Krog (1973) or Thomson (1979) to see if the species is included in their

Overall, this field guide is extremely well written.
Very clear.

keys. If it is, try to arrive at the same name using these other keys.

The next steps are to obtain a voucher specimen of that species to compare with yours, and to have a knowledgeable botanist verify your determination. Even if you have access to a herbarium or reference collection, it is still important to have a determination verified by an expert. These steps are essential to accurate and consistent plant taxonomy.

As you become familiar with various lichen features and species, you can make notes and drawings on the blank page facing each printed page. Each of these blank pages has a heading of "Notes and Sketches" which provides space for users to write down supplementary information. Since printed illustrations are not in the present draft, this feature encourages users to record their own illustrations.

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MASTER KEY

- 1 Lichen thallus fruticose; stalk-like with or without branches; with or without cups. 2

Lichen thallus foliose; papery and leaf-like or strap-like, loosely to tightly attached to substrate. Key 8

- 2 (1) Lichen color dark: black, brown, dark gray or blue-black, includes deep golden yellow species. 3

Lichen color light: white, pale gray or green, pale tan, pale orange or yellow; bases may be dark. 4

- 3 (2) Lichen with continuous rounded outer surface or cortex, (break stalk and use hand lens); branched or unbranched. Includes Alectoria and Cornicularia. Key 1

Lichen flattened: may have edges which curl around to look like a tubular outer cortex. Includes brown and golden Cetraria species. Key 2

- 4 (2) Lichen hollow, or with webby center; may be flattened, and may have edges which curl around to look like a tubular outer cortex as in Cetraria cucullata. 5

Lichen solid or with central core. Key 3

Note: If you know you have Stereocaulon go to Key 4, otherwise use Key 3.

- 5 (4) Inside of hollow lichen stalk (podetium) lined with a yellowish cartilagenous layer. This layer is somewhat shiny and contrasts with the surrounding layer of cottony medulla (break stalk and use hand lens). Includes all Cladonia and Cladina species. Note: If you cannot be sure, try Key 5 vs. Key 6 or 7. 6

Inside of hollow stalk without cartilagenous layer, or cottony and webby. Key 5

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- 6 (5) Lichen pale yellow, gray or white; usually highly branched; no primary foliose (squamulose) thallus present. Includes Cladina (reindeer lichen) and some Cladonia species. Key 6

Lichen white, pale yellow, gray or greenish-brown; round stalks with some or no branches; may have cups and/or knobby apothecia at tips; primary thallus (squamules) present at base and may also be on stalks. Includes cup and horn lichens in Cladonia.

Key 7

NOTES AND SKETCHES

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Key 1. Dark Fruticose Lichens Cornicularia and Alectoria *

- 1 Lichen color dark brown to black on main branches, always becoming pale brown or gray at branch tips; surface shiny (use hand lens); short branchlets 1-2 mm long (spinules) usually present. Distribution largely coastal. P+ red at tips.

7. Alectoria tenuis

Lichen color pale on main branches to dark at tips, or uniformly dark.

2

- 2 (1) Lichen color pale yellow or greenish tan on main branches, darkening to blackish at tips; light spots or "pores" (pseudocyphellae) evident on dark branches; surface dull, not shiny (use hand lens); bases may become brown.

3

Lichen color brown or black.

4

- 3 (2) Lichen color pale yellow on main branches, darkening to blue or bluish-black at branch tips; on bluish branches there are yellow spots or "pores". P-, C-.

5. Alectoria ochroleuca

Lichen color grayish-tan on main branches; darkening to black at tips of branches; on black branches there are tan spots or "pores". P+ yellow then orange, C+ red.

3. Alectoria nigricans

- 4 (2) Soredia present in small white rounded patches, scattered sparsely over branches; color dark brown to black; main branches thick. P+ red, soredia only.

1. Alectoria chalybeiformis

Soredia not present, although small white or brown "pores" may be present.

5

- 5 (4) Lichen black, entire lichen very small, mat height usually less than 1 cm; densely branched and hairlike; firmly attached to rock surfaces at least at tips; "pores" and soredia absent; apothecia may be present. P-, C-.

6

Lichen rich brown to dark brown, not black; usually more than 1 cm tall; loosely attached to substrate; "pores" may be present; apothecia usually absent. P- or P+ red, C- or C+ red.

7

* (including Bryoria and Pseudephebe)

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- 6 (5) Lichen closely appressed to rocky substrate, attached over most of thallus by small fungal threads; branches becoming flattened with knotty swellings and becoming almost foliose or fruticose at center of thallus.

2. Alectoria minuscula

Lichen forming small cushions; attached to rocky substrate at branch tips; branches cylindrical, not becoming flattened.

6. Alectoria pubescens

- 7 (5) Lichen dark brown to black, even-colored; forming entangled mats 2-10 cm tall; branches shiny (use hand lens); branchlets 1-2 mm long (spinules) usually present; "pores" brown to black and usually present; apothecia absent. P+ red.

4. Alectoria nitidula

Lichen bright to dark red-brown, even-colored; branches shiny and divergent; white "pores" very common on branches; branch tips small and delicate, branches very brittle; apothecia may be present. P-.

8

- 8 (7) Lichen usually 5-10 cm tall, very shiny (use hand lens); branches long and tapering to delicate branchlets. C+ red.

9. Cornicularia divergens

Lichen less than 5 cm tall; surface smooth; branches very angular, becoming flattened; branches and branchlets short and spiny. C-.

8. Cornicularia aculeata

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Key 2. Brown and Bright Yellow Species of Cetraria

- 1 Lichen bright golden yellow. 2
Lichen some shade of brown. 3
- 2 (1) Lichen with soredia on margins; lobes leathery; usually found on twigs. (p.35 Hale). 11. Cetraria pinasti
Lichen without soredia; lobes brittle; found on calcareous soil. 14. Cetraria tilesii
- 3 (1) Lichen large (15 mm across), tough and leathery, forming large clumps; dark brown and curled up when dry; olive green and extended when wet; branches coarse and flattened with pointed tips; large whitish patches on lobe undersides; not anchored to substrate; found in depressions such as snowbeds. Medulla UV + white, KC + pink or red. 12. Cetraria richardsonii
Lichen not leathery, not turning green when wet. 4
- 4 (3) Lichen distinctly foliose, entire lichen closely attached to rock substrate, growing in a circle or rosette; margins thick and forming a channeled upper side; apothecia may be present in center of lichen. Note: Morphological distinction beyond this point is subtle, see Thomson 1979. 5
Lichen erect or partly erect, attached to substrate only at base of lobe or "stalk." 6
- 5 (4) Underside dark, lighter only at margins. Margin of apothecia crinkled; medulla P + orange, K + yellow then reddish. (p. 145 Hale). 6. Cetraria hepaticum
Underside lighter than upper side; margin of apothecia smooth; medulla P-, K-. 2. Cetraria commixta

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- 6 (4) Lobes narrow and strap shaped; long cilia (to 1.5 mm) projecting from lobe margins; lichen very dark and almost black; upper surface of lobes slightly channeled; few tiny whitish patches (pseudocyphellae) on lobes. 7

Lobes broad with or without lobes rolled inward, or if narrow with rolled margins; no long cilia although short stubby projections may be present, white patches may be present on lobes. 8

- 7 (6) Lobes to 2 mm broad and 4 cm long; branch tips unevenly blunted or pointed and rising to look fruticose; both sides very dark brown, bases may be paler. Medulla I + blue.

4. Cetraria elenkinii

Lobes to 1 mm broad, forming a small tuft or mat; branch tips blunted; upper side very dark, lower side paler; lichen very easily overlooked on stones or mosses. Medulla I + blue.

10. Cetraria nigricans

- 8 (6) Lobes narrow, margins rolled inward and sometimes rippling; branching dichotomous, tips curled; upper lobes dark shiny brown, lower lobes pale brown; long white patches if present usually restricted to the lobe margins. 9

Lobes broad at least at base, white patches may be present on lobes; lobe edges at least partly curled. 11

- 9 (8) Lichen with rippled inrolled margins (as in C. cucullata) tips turned back and curled; angle of branching very wide; branches short; spiny projections rare; few or no white patches on lower lobe margins; chestnut brown and shiny.

8. Cetraria kamczatica

Lichen with margins rolled inward but not rippling; at least some linear white patches present along margins. 10

- 10 (9) Lichen almost tubular, small (often less than 6 cm tall); lobe margins with stubby projections; few or no narrow white patches on margins, white spots uncommon on lobes. Medulla I + blue.

5. Cetraria ericetorum

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Lichen with inrolled margins, often longer than 6 mm; lobe margins with stubby projections; very distinct linear white patches along margins, none across lobes; branching distinctly in 2's or 3's, even and symmetrical, with third-order branching common. P + red, K + yellow then red, medulla I + blue.

9. Cetraria laevigata

- 11 (8) Lobes with large white patches scattered over the surface, some patches also along lobe margins; stubby projections along lobe margins; branches broad and rippling, branching uneven and sometimes dichotomous; color dark brown where sun-browned to pale tan where protected; base becomes orange-red. Note: This species varies greatly in color and shape; when it has few scattered white patches it resembles C. laevigata, but always has broader, more irregular branching. P + red. (p. 169 Hale).

7. Cetraria islandica

Lobes broad; color brown to tan; few or no white patches over lobes or along margins. 12

- 12 (11) Lobes flattish, broad and fused at bases but tapering to very slender, delicate tips; entire lichen thin and delicate; color usually pale brown to tan; few or no white patches; no spiny lobe margins; found in very wet sites and snowbeds. Medulla C + rose.

3. Cetraria delisei

Lobes curling, broad to very broad; tips rounded and curling; branching very coarse and irregular, lobe margins with few spiny projections, few or no white patches on lobes. 13

- 13 (12) Lobes very broad and fused at bases, curled; tips broadly rounded, margins partly rolled inward; branching broad and irregular; color rich brown with pale bases, shiny; lobe margins may have smaller lobes (lobules); found in very wet sites.

1. Cetraria andrejevii

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Lobes broad, flat with a central depression or groove; branching irregular; color light greenish brown to medium brown and irregularly mottled, shiny, lower surface paler; lichen may be densely twisted or tangled; found usually on branches of small shrubs but sometimes on shaded moss.

13. Cetraria subalpina

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Key 3. Pale, Solid Fruticose Lichens

- 1 Lichen pale yellow or yellow-green; lichen flattened, angular or round in cross-section. 5

Lichen white, gray, bluish or partly orange-brown, but not yellow; lichen round in cross-section. 2

- 2 (1) Lichen white to pale gray, up to 7 cm tall, tips rounded, few branches, found in seepages and snowbeds. Siphula ceratites

Lichen gray, bluish or partly orange-brown. 3

- 3 (2) Lichen "stalk" whitish to gray or pinkish, covered with little grainy or knobby lobes (phyllocladia) which are pale gray; brown apothecia may be present; small colonies of blue-green algae may be present as dark or black spots; found on acidic mineral soil or sparse vegetation. (p. 225 Hale) Stereocaulon. Key 4

Lichen bluish-gray, especially undersides; top of branches orange to brown from sun exposure; outer surface (cortex) smooth and shiny; many small lateral branches at tips of main "stalks". Note: morphological distinction beyond this point is very subtle. (p. 227 Hale) Sphaerophorus. 4

- 4 (3) Lichen stiff, not fragile; partly with small pitted areas; Medulla I+ blue, UV+ blue.

Sphaerophorus globosus

Lichen fragile; no pitted areas. I-.

Sphaerophorus fragilis

- 5 (1) Lichen round in cross section. 6

Lichen angular or flattened in cross section. 9

- 6 (5) Lichen color pale yellow on main branches, with sun-exposed areas darkened to blue or bluish black; on bluish branches are conspicuous pale spots or "pores"; lichen tough, not pliable.

Alectoria ochroleuca

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Lichen color pale yellow to yellowish green, darkening only at base; lichen tufted and pliable; central core somewhat elastic (pull a branch apart); most branches perpendicular to main branches, looking bushy; main stalk firmly anchored to bark or rock; usually on trees but on rocks beyond treeline. Note: Specimens may be hard to distinguish when small: consult Thomson (1979). (p. 212-220 Hale) Usnea. 7

- 7 (6) Found on rocks, soredia form fused lumps and have projecting branchlets.

Usnea scholanderi

Found on trees, possibly on rocks, soredia not forming large fused masses. 8

- 8 (7) Lichen up to 10 cm long; soredia in small pitted patches; branch tips sparsely branched, long and slender.

Usnea glabrescens

Lichen up to 4 cm long; soredia in small patches; lateral branches repeatedly branched; branch tips not elongated. Note: either species may be stunted by arctic growth regimes.

Usnea lapponica

- 9 (5) Lichen thick, 3-7 mm in diameter, appearing stout and inflated but somewhat flattened; surface irregularly pitted and perforated; few stubby branches. (p. 203 Hale).

Cladonia boryi

Lichen usually 3 mm or less in diameter; surface not irregularly pitted and perforated; highly branched. 10

- 10 (9) Lichen flattened in cross section, slightly inflated, very small and tufted; delicate branches; pale yellow-green; surface smooth and slightly shiny; firmly attached by a holdfast.

Ramalina.

11

Lichen angular in cross section, large and tufted; branches coarse; yellowish-green; surface rough or sorediate; may be attached by a holdfast. (p. 205 Hale) Evernia 12

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- 11 (10) Lichen webby and partly hollow inside, soredia sparse or absent; may have pale yellow apothecia to 4 mm across at or near lobe tips; found on soil.

Ramalina alquistii

Lichen webby inside; pliable; soredia abundant and powdery on lobes; base darkening; apothecia not known in Alaskan material; found on bark or rocks. (p. 205-206 Hale)

Ramalina pollinaria

- 12 (10) Lichen pale yellow; lacking soredia or isidia; soft but fragile; found on calcareous soil or gravel.

Evernia perfragilis

Lichen yellowish-green; soredia coarse and abundant in patches; soft and pliable; found on trees or on rocks beyond tree line.

Evernia mesomorpha

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Key 4. Species of Stereocaulon

- 1 Lichen on rocks, attached by holdfasts; stalks with little or no tomentum. 8

Lichen on mineral soil, gravel or between rocks; stalks loosely attached and easily removed, usually with fuzzy or webby tomentum on the stalks and main branches. 2

- 2 (1) Lichen forming flattened mats, with some stalks upright; most stalks with distinct upper and lower sides, dorsiventral so that lobes are more visible on upper side. 3

Lichen with erect stalks; generally no upper or lower sides, branches and lobes radiate around stalks. 6

- 3 (2) Lichen with distinct main stalks; stalks and branches with thick gray webby tomentum; lobes flattened and rounded, margins with rounded teeth, thickly covering branches on upper side; small colonies of blue-green algae pale and hidden by tomentum; apothecia common along branches but not at tips, stalk K + yellow, P + yellow or orange red or P-.

11. Stereocaulon tomentosum

Lichen with or without distinct main stalks; lobes lumpy or wartlike, or with finger-like projections, but not flattened and rounded; tomentum usually dark gray or pale gray to white or pink, sparse to abundant, but is combined with different features than in S. tomentosum. 4 4

- 4 (3) Lichen with distinct main stalk, with branches on upper stalk covered with lobes. 5

Lichen with tangled mass of branches and lobes, white stalks not distinct, very fragile, little or no tomentum; lobes coarse and granular, fusing; colonies of blue-green algae rare, pale or brownish; dark brown apothecia may be present on branches or tips; stalk K + yellow; found in wet sites, stream beds.

7. Stereocaulon rivulorum

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- 5 (4) Lichen partially prostrate and partially erect; stalks with white to pale pink tomentum; lobes pale gray or whitish but not bluish dark gray, thick and knobby and appearing swollen; colonies of blue-green algae in whitish lumps in tomentum on lower side of stalk and branches; apothecia reddish brown at branch tips, if present; stalk K-, lobes K+ yellow, P+ yellow.

1. Stereocaulon alpinum

Lichen lying in flattened colonies on rocky substrate; highly branched; stalks with bluish or dark gray tomentum; lobes gray or bluish flattened, scale-like with small lumps; no colonies of blue green algae in Alaskan specimens; stalk K+ yellow.

8. Stereocaulon saxatile

- 6 (2) Lichen loosely attached and easily lifted off substrate; stalks with dark gray tomentum at least at base, paler above; lobes clustered like grapes, small (0.1 mm broad) and granular, grayish white, sometimes finger-shaped; colonies of blue-green algae dark, lumpy and visible; few apothecia on branch tips; stalk K + yellow, P + yellow.

6. Stereocaulon paschale

Lichen with grayish white to pinkish tomentum on stalk, colonies of blue-green algae pale or obscured by tomentum. 7

- 7 (6) Lobes abundant on stalk base and on branches extending out beyond tomentum, elongated and cylindrical; colonies of blue-green algae common on branches, pale brown; apothecia rare on branches or tips; stalk K + yellow.

4. Stereocaulon glareosum

Lobes very small and granular, scattered along stalk and branches, sometimes obscured by dense tomentum; colonies of blue-green algae mostly covered by tomentum, dark brown; apothecia common on branch tips, dark brown; stalk K + yellow.

5. Stereocaulon incrustatum

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- 8 (2) Lichen firmly attached to rock substrate; lobes rounded; soredia or grainy areas present on at least some lobe tips.

9

Lichen loosely to firmly attached; lobes on branches with tiny finger-like projections.

10

- 9 (8) Lichen with distinct upper and lower sides; branches with rounded patches of soredia; lobes rounded, somewhat flattened and stalked with darker centers and paler margins; small colonies of blue-green algae common as dark brown lumps on stalks and branches; apothecia rare, blackish brown on branch tips; stalk K + yellow, P + sulphur yellow (P + orange in S. vesuvianum, a chemically differentiated species).

10. Stereocaulon symphycheilum

Lichen with sparse tomentum on upper stalks; lobes granular and grayish white, may fuse into lumpy masses which look like soredia, colonies of blue-green algae rare and inconspicuous; dark brown apothecia may be present on stalk tips; stalk K + yellow.

2. Stereocaulon botryosum

- 10 (8) Lichen small, 1.5 to 2.5 cm tall, loosely attached; stalk dark at base, paler above, no tomentum; few branches; lobes very tiny 0.2 to 0.4 mm long, grainy and branched like tiny fingers all over the upper branches; colonies of blue-green algae common in olive-brown lumps; dark brown apothecia may be present at branch tips; stalk K + yellow.

9. Stereocaulon subcoralloides

Lichen taller, 2 to 8 cm tall, firmly attached, with stout main stalks; tomentum at base of stalk; lobes to 1 mm long, repeatedly branched like fingers; colonies of blue-green algae rare, pale brown, immersed in tomentum; brown apothecia common at branch tips; stalk K + yellow, P + orange.

3. Stereocaulon dactylophyllum

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Key 5. Hollow Fruticose Lichens*, White or Yellow to Yellow-brown

- 1 Lichen with continuous rounded outer surface or cortex (break stalk and use hand lens); branched or unbranched. 4

Lichen flattened; may have edges which curl around to look like a tubular outer cortex. (Fig. 391, p. 198 Hale). 2

- 2 (1) Lobes flattened and appearing wrinkled, color pale yellow, base turns deep yellow.

Cetraria nivalis

Lobes with edges which curl around to look like a tubular fruticose lichen with a seam (cut a cross section); smaller branches are less tightly curled. 3

- 3 (2) Lichen color pale yellow (same as C. nivalis), base turns magenta red. (p. 198 Hale).

Cetraria cucullata

Lichen color pale tan or greenish to brown, base turns orange. This pale color variation is found in lichen mats protected from sun-browning. Short projections present along lobe margins. P + red. (p. 169 Hale, p. 53 Dahl and Krog).

Cetraria islandica

- 4 (1) Thallus tips pointed, usually unbranched; white or cream colored; apothecia absent. Note: if solid, is Siphula. Chemical characters are used beyond this point to separate two species which may occur together. (p. 228 Hale).
Thamnolia subuliformis s.l. 5

Thallus tips rounded; lichen looks inflated; few main branches, may have many stubby "branchlets"; cottony inside; yellow or yellowish-brown; brown apothecia may be present at branch tips.
Dactylina 6

*(with no cartilaginous layer inside the stalk; excludes Cladonia)

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- 5 (4) UV +, more common in northern North America.

Thamnomolia subuliformis

UV-.

Thamnomolia vermicularis

- 6 (4) Lichen with few main branches, no "branchlets"; thallus tips rounded like fingers, pale yellow-green and may be sun-browned with a dark base. Note: chemical characters are used beyond this point to separate two species which may occur together. (p. 202 Hale). Dactylina arctica s.l. 7

Lichen with short, stubby "branchlets."

- 7 (6) P + orange red.

Dactylina beringica

P-.

Dactylina arctica

- 8 (6) Lichen branched with short stubby branches which are fragile when dry; yellow to brownish, or tan-violet with a whitish "bloom" (powdery appearance). P + or P -.

Dactylina ramulosa

Lichen sparingly branched, pliable when dry, surface pitted and appearing wrinkled; pale yellow to greenish, may be sun-browned. May resemble a more inflated version of Cetraria nivalis.

Dactylina madreporiformis

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Key 6. Branched Species Of Cladoniaceae

- 1 Lichen forming compact rounded heads 2-3 cm in diameter; individual podetia very densely branched with no conspicuous main branches; usually 4-6 branches at tips radiating from a perforation (open axil); color pale yellow or white. P- or P+ yellow. 7. Cladina stellaris
- Lichen forming mats without rounded heads; individual podetia with main branches and smaller side branches; color pale yellow or grayish-white. 2
- 2 (1) Lichen color grayish to white or bluish, with no yellow present; some brown color may be present on upper branches exposed to sun; base of podetia may darken to dark gray or black, with white spots. 3
- Lichen color pale yellow, with brownish common on upper branches exposed to sun; color in shaded habitats greenish yellow; base of podetia may not darken to dark gray or black. 4
- 3 (2) Lichen highly branched with branches interwoven; branching mostly in 4's, with small delicate tips; surface of branches dull, fibrous, lacking a cortex (use hand lens). P+ red. (Reindeer lichen) 6. Cladina rangiferina
- Lichen stout and sparsely branched; branching mostly dichotomous thus with fewer branches than C. rangiferina; branches short and stout. Surface of upper branches smooth, not fibrous or web-like (use hand lens). P-. 9. Cladonia thomsonii
- 4 (2) At least some branches forming narrow cups at the tips; the cups may have additional branches growing upward from the edges of the cup; axils may be closed or open; color of podetia greenish yellow; base does not darken to black. P-. 2. Cladonia amaurocraea
- Branch tips with no cups present. 5
- 5 (4) Podetia thick, 3-6 mm in diameter, appearing stout and inflated; surface irregularly pitted and perforated. P-. 4. Cladonia boryi

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Podetia 2 mm or less in diameter, not appearing inflated; surface fibrous or smooth but not pitted; branches sparse to abundant.

6

- 6 (5) Podetia approximately 2-3 mm in diameter, appearing short but not inflated; branches usually dichotomous but sometimes trichotomous (branching in 3's), short and stubby.

7

Podetia slender, 1-2 mm in diameter, highly branched in 3's or 4's with branches interwoven; surface dull and fibrous, lacking a continuous cortex (use hand lens) but not pitted. (Reindeer lichens)

8

- 7 (6) Podetia surfaces smooth to shiny, upper cortex present (use hand lens); branches may form dense mats or tufts; spiny branch tips divergent and often brownish; axils perforated and dilated; podetia color yellow to pale yellow; base may become whitish to brown but not black with white spots; branching may resemble C. amaurocraea but cups are absent. P-.

10. Cladonia uncialis

Podetia surface dull and fibrous, no upper cortex (use hand lens); few, short branches which are mainly vertical; podetia color pale gray-yellow or brownish; base turns black with white spots. P+ red.

1. Cladonia alaskana

- 8 (6) Branching pattern with a main stem and small dichotomous branches, appearing delicate and windswept. Distribution largely coastal. P+.

8. Cladina tenuis

Branching pattern with a main stem and branches usually in whorls of 3-4, giving a bushy appearance. Note: morphological distinction beyond this point is very subtle. If distinction cannot be made, designate as Cladina arbuscula/mitis or C. arbuscula aggr.

9

- 9 (8) Nodes between branches short enough to give a tufted, well-combed appearance; branch tips tend to point in one direction; main stem robust. P+.

3. Cladina arbuscula

Nodes between branches longer, appearance is less tufted; branch tips tend to point in several directions; main stem thin. P-.

5. Cladina mitis

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Key 7. Cup and Horn Lichens

- 1 Lichen color yellow or yellowish green (usnic acid present). 2
- Lichen color white or gray: greenish gray, whitish gray, or brownish gray, but not yellow.
- 2 (1) Lichen with cups, varying from single goblet-shaped cups, to shallow flaring cups with or without "branches" or perforations from the edges or center of the cups; apothecia may also be present. 5
- Lichens without cups, with blunt tips which may have red or brown apothecia. 3
- 3 (2) Lichen stalk covered with fine powdery soredia, like flour. 4
- Lichen stalk with no soredia, covered instead with tiny lobes (squamules); tips usually with red apothecia; bases are bright yellow. Cladonia bellidiflora
- 4 (3) Lichen tall 20-80 mm, usually unbranched, slender; soredia usually on entire stalk and on edges of basal lobes (squamules); apothecia pale brown, may be present at tip of stalks. Cladonia cyanipes
- Lichen short, to 20 mm, unbranched; soredia on entire stalk; tips may be blunt or with very fine cups, or may have pale brown apothecia. Cladonia bacilliformis
- 5 (2) Lichen stalk covered with fine powdery soredia, like flour (use hand lens). 6
- Lichen stalk with smooth or lumpy yellow-green surface, but not with soredia (use hand lens). 10
- 6 (5) Lichen short and stout, cups flaring widely from base; soredia on upper parts of cup and inside cup; apothecia may be present on edges of cup. 7

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Lichen tall, usually 25 mm or more, cups narrow and irregularly expanded or branched at the top edges; soredia on upper part of stalk or on whole stalk; apothecia may be present. 8

- 7 (6) Lichen usually 10-20 mm tall, resembling a goblet-shaped cup; edge of cup rarely with little proliferating "stalks", but may have scarlet apothecia or small red dots (use hand lens) called pycnidia. Cladonia pleurota

Lichen usually 20-30 mm tall, flaring widely and irregularly from base; edge of cup may have extending branches; powdery soredia on most of lichen; cup may have pale brown apothecia or small brown dots on upper edges.

Cladonia carneola

- 8 (6) Lichen pointed, narrow and horn-like, tips with some very narrow cups; whitish soredia on upper portion; many lobes around base extending up the stalk; apothecia rare, dark brown. Cladonia bacilliformis

Lichen 2.5-8.5 cm tall, flaring into cups, not pointed; cups tall, narrow and irregularly expanded, sometimes with little "stalks" proliferating from margin of cup; lobes at base but not on stalk; apothecia rare, scarlet. Note: Morphological distinction beyond this point is subtle. 9

- 9 (8) Lichen with small lobes 2-4 mm long at base of stalk; cup margins entire, or with little "stalks" proliferating on edges; medulla UV-. Cladonia deformis

Lichen with lobes 5-10 mm long at base of stalk; cup margins commonly with little proliferating "stalks"; sides of cups often split or with fissures; medulla UV+ bluish.

Cladonia gonecha

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- 10 (5) Lichen unbranched, cups short and stout, goblet shaped, flaring from base; cup margins may have proliferating stalks and red apothecia and/or pycnidia. Note: morphological distinction beyond this point is subtle. 11

Lichen branched or unbranched, tall and slender with small or narrow cups, cups originating high on stalks at tips, cup margins may "teeth" or small proliferating stalks and red or brown apothecia. 12

have

- 11 (10) Lichen with slightly lumpy surface due to distinct green clumps of algae (areoles) on the stalk (use hand lens); medulla UV-. Cladonia coccifera

Lichen with smaller crowded lumps of algae which look lumpy even without a hand lens, and may look like small lobes (squamules); medulla UV+ white to bluish. Cladonia metacorallifera

- 12 (10) Lichen unbranched, stalks tall and slender, with lobes (squamules) covering much of the stalk; some small cups present at stalk tips; red apothecia and/or pycnidia may be present; base often is deep yellow. Cladonia bellidiflora

Lichen branched; branches with small flattened cups on some branch tips, cups may have little spines on margins; brown apothecia and/or pycnidia may be present. Cladonia amaurocraea

- 13 (1) Lichen creamy white or pale gray, solid or hollow, stalks unbranched or sparingly branched, and slender. 14

Lichen greenish gray or greenish brown, but not white or pale gray. 15

- 14 (13) Lichen creamy white; stalk hollow; tips pointed; stalk UV+ or -, K+ yellowish. See Key 5, couplet 5 for species. Thamnolia subuliformis s.l.

Lichen white to pale gray; stalk solid, with long wrinkles; tips rounded; stalk UV-, K+ orange. Siphula ceratites

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- 15 (13) Lichen with soredia present on at least part of stalk, or on upper portions of cups. 16

Lichen without soredia, surface may appear lumpy but never powdery or covered with flour-like or pollen-like soredia. 25

- 16 (15) Lichen with cups, ranging from distinct goblet shape or narrow, small cups; lichen greenish gray. 17

Lichen with no cups, stalks ending in pointed tips or knobby apothecia 21

- 17 (16) Lichen unbranched; cups goblet-shaped and flaring; upper stalks and cups covered with fine powdery soredia. 18

Lichen branched, tall and slender with small or narrow cups, cups originating high on stalks at tips. 19

- 18 (17) Lichen stalk slender with narrow cup flaring from upper part of stalk; soredia very fine like flour (use hand lens). Note: if stalk is over 20 mm tall, it can be called C. major.

Cladonia fimbriata

Lichen stalk broader; cups flaring more gradually from the base, goblet-shaped; soredia grainy (use hand lens), present on and in cups. Note: arctic material is P+ red, see Hale p. 178 for chemically differentiated species.

Cladonia chlorophaea

- 19 (17) Cups asymmetrical, open into center of stalk, edges inrolled; small branches growing out of the edges of the cups; soredia on most of stalk; stalk P-.

Cladonia cenotea

Cups not with inrolled edges.

20

- 20 (19) Stalks with soredia on upper part only; upper stalk greenish white, lower stalk darker greenish or brownish gray and with sparse squamules; may have one or a few tiny cups at the stalk tips; stalk P+ red.

Cladonia cornuta

Stalks entirely covered by soredia; few or no squamules on stalk; soredia very fine and powdery; stalk P+ red.

Cladonia subulata

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- 21 (16) Stalk branched, usually in 2's; lobes (squamules) dense on whole stalk; soredia present especially on upper stalk; stalk P+ red. Cladonia scabriuscula

Stalk branched or unbranched, but with few or no squamules on stalk. 22

- 22 (21) Stalks basically unbranched, with soredia on upper part only; upper stalk greenish white, lower stalk darker greenish or brownish gray and with sparse squamules; may have one or a few tiny cups at stalk tips; stalk P+ red. Cladonia cornuta

Stalk with few to several branches, entire stalk with soredia, or soredia scattered in patches but not restricted to upper part of stalk. 23

- 23 (22) Stalk with few branches; fine powdery soredia on entire stalk; tips may have one or a few tiny cups or small brown apothecia present; squamules at base of stalk or absent; stalk P-, UV+ white. Cladonia glauca

Stalk may be branched but soredia are in scattered patches on stalk; squamules present on at least lower half of stalk. Note: morphological distinction beyond this point is subtle. 24

- 24 (23) Stalk usually branched in upper part; tips blunt or with apothecia; large patches with soredia, and patches without a cortex; stalk P+ yellow, K+ yellow then red (K+ yellow in C. norlinii, a chemically differentiated species). Cladonia acuminata

Stalk with few or no branches, otherwise very similar; stalk P-, K-. Cladonia decorticata

- 25 (15) Large lobes 5-30 mm long and 1-8 mm wide (squamules) at stalk base; cups present or absent. 26

Lobes (squamules) 1-5 mm long and 1-4 mm wide at stalk base, may also be on stalk; cups present or absent. 27

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- 26 (25) Large lobes 10-30 mm long and 1-7 mm wide at base and on stalk, lobes chalky white on lower surface, green to brownish on upper surface; stalk slender and small, whitish, often smaller than the squamules; branches with narrow irregular cups at tips; stalk K+ yellow, P+ red or P-. Cladonia turgida

Large lobes 8-15 mm long and 1-8 mm wide at base; stalk with broad cup to 7 mm wide at tip, may have little stalks growing out of cup margins; brown apothecia may be present at tips or cup margins.

Cladonia macrophyllodes

- 27 (25) Lichen stalk with cups, from large goblet-shaped cups to narrow or irregular split cups, with or without little stalks along the cup margins or centers. 28

Lichen stalk pointed or tipped with apothecia; if branched, branches not originating from the margin of a cup; no cups present. 38

- 28 (27) Lichen with stout goblet-shaped cups, flaring gradually from the base; usually without little stalks along cup margins; stalk covered with lumps (use hand lens) which are distinct clumps of green algae; no squamules on stalk. 29

Lichen cups flaring out from higher up on the stalk, not flaring gradually from the base, usually with little stalks growing out of the cups; with or without squamules on the stalk. 30

- 29 (28) Squamules at the base of stalk growing in a flattened rosette or circle; lichen color gray to sun-browned; commonly found on calcareous soils. Cladonia pocillum

Squamules loosely growing at base of stalk, not flattened and not growing in a distinct rosette; lichen color gray to sun-browned; found on soil and rotting wood. (Pixie cup lichen)

Cladonia pyxidata

- 30 (28) Lichen cups with slender stalks growing out of the center of the cups; sometimes with several tiers of cups; reddish brown apothecia may be present. 31

Lichen cups with stalks growing out of the margin of the cups, or no such proliferating stalks. 32

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- 31 (30) Lichen with one or two stalks growing up from the center of a broad cup below; outer surface (cortex) continuous, brownish gray; stalk K-, P+ red. Cladonia verticillata

Lichen with one to several stalks growing up from the center of a narrow cup below; patches on outer surface may not have a cortex and are dull and whitish (use hand lens); base is black with white spots; some squamules present on stalks and cups, stalk K+ yellow, P+ red. Cladonia lepidota

- 32 (30) Stalks with black bases which have white spots. 33

Stalks without spots at the base, regardless of color. 34

- 33 (32) One to several stalks growing from the margins of cups; squamules on stalk; cups split and irregular; interior of cups closed; brown apothecia common stalks growing out of cups; stalk K-, P+ red.

Cladonia lepidota

- 34 (32) Lichen stalk richly branched, some branches originate from expanded cup margins; squamules present on branches; stalk P+ red. Note: may resemble a reindeer lichen but has a cortex and some squamules on branches. The amount of branching and squamules is variable. C. pseudorangiformis (P+ yellow) and C. subrangiformis are chemically differentiated species.

Cladonia furcata s.l.

Lichen stalk sparingly branched, or with few "branches" from a cup margin. 35

- 35 (34) Lichen stalk branched at least at tips, some branches originate from expanded cup margins. 36

Lichen stalk not branched, or with few "branches" from a cup margin. Large brown apothecia may be present. Note: Morphological distinction beyond this point is subtle. 37

- 36 (35) Lichen branches with dense, small squamules; open cups may be small and obscured by squamules; apothecia rare; UV+ white.

Cladonia squamosa

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Lichen branches with few or no squamules; cups irregular and open; tips are delicate and finely branched; stalk color brown near tips, whitish near base; UV+ white.

Cladonia crispata

- 37 (35) Three major varieties of Cladonia gracilis may be found as follows:

- a) lichen slender and unbranched, pointed and sun-browned in upper portion 30-80 mm tall; stalk K-, P+ red.

Cladonia gracilis var. gracilis

- b) as above except larger, 50-100 mm tall, 2.5 mm thick.

Cladonia gracilis var. elongata

- c) lichen gray or brownish gray with cups; stalks on cup margins; large brown apothecia common on stalks and/or cup margins; found in sheltered microhabitats and in forests; stalk K-, P+ red.

Cladonia gracilis var. dilatata

Lichen cupless and pointed, or with narrow open cups and stalks from the cup margins; apothecia brown, may be present on cup margins; varies from gray to sun-browned; stalk K+ yellow, P+ red. Note: a chemical test is the most reliable way to distinguish this species from C. gracilis, or designate unknowns as C. gracilis/ecmocyna.

Cladonia ecmocyna

- 38 (27) This group includes the following species:

C. cariosa
C. macrophylla
C. subfurcata
C. ecmocyna
C. gracilis
C. furcata s.l.
C. squamosa s.l.
C. turgida
C. crispata
C. lepidota

These should be keyed in Hale until a new key can be written.

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